

CLAIMS

1. An air-fuel ratio control apparatus of an internal combustion engine comprising:

a first exhaust gas purifying catalyst disposed in an exhaust passage;

a second exhaust gas purifying catalyst disposed downstream of the first exhaust gas purifying catalyst;

first air-fuel ratio acquiring means provided upstream of the first exhaust gas purifying catalyst, for acquiring an air-fuel ratio of exhaust gas;

second air-fuel ratio acquiring means for acquiring an air-fuel ratio of the exhaust gas flowing into the second exhaust gas purifying catalyst; and

air-fuel ratio controlling means for controlling an air-fuel ratio in the internal combustion engine according to the air-fuel ratio acquired by the first air-fuel ratio acquiring means and the air-fuel ratio acquired by the second air-fuel ratio acquiring means,

wherein the air-fuel ratio controlling means comprises: lean control means for controlling an air-fuel ratio in the internal combustion engine until the second exhaust gas purifying catalyst becomes lean after completion of a fuel quantity increasing operation of the internal combustion engine; and intermediate lean control means for performing, at least one time, control to change the air-fuel ratio in the internal combustion engine to a lean air-fuel ratio within the range enough to make the first exhaust gas purifying catalyst lean and not

enough to make the second exhaust gas purifying catalyst lean between the fuel quantity increasing operation and the air-fuel ratio control by the lean control means.

2. The air-fuel ratio control apparatus of the internal combustion engine according to claim 1, wherein the air-fuel ratio controlling means performs an air-fuel ratio control by the lean control means during an idle operation of the internal combustion engine.

3. The air-fuel ratio control apparatus of the internal combustion engine according to claim 1 or 2, wherein the air-fuel ratio controlling means performs an air-fuel ratio control by the intermediate lean control means during a substantially steady operation in a partial load region of the internal combustion engine.

4. The air-fuel ratio control apparatus of the internal combustion engine according to any one of claims 1 to 3, wherein the intermediate lean control means makes the air-fuel ratio in the internal combustion engine change to a lean air-fuel ratio by the smaller amount than the lean control means.

5. The air-fuel ratio control apparatus of the internal combustion engine according to any one of claims 1 to 4, wherein the air-fuel ratio controlling means does not perform any air-fuel ratio control by the lean control means and the intermediate

lean control means when judged that the temperature of the first exhaust gas purifying catalyst or the temperature of the second exhaust gas purifying catalyst is higher than a predetermined temperature at which the degradation of the catalyst is intensified.

6. The air-fuel ratio control apparatus of the internal combustion engine according to any one of claims 1 to 5, wherein the air-fuel ratio controlling means comprises a rich control means for performing control to change the air-fuel ratio in the internal combustion engine to a rich air-fuel ratio within the range not enough to make both of the first exhaust gas purifying catalyst and the second exhaust gas purifying catalyst rich after the air-fuel ratio control by the lean control means.

7. The air-fuel ratio control apparatus of the internal combustion engine according to any one of claims 1 to 6, further comprising: learning controlling means for controlling feedback learning relating to the air-fuel ratio in the internal combustion engine; and

correcting means for feedback correcting a quantity of fuel to be supplied to the internal combustion engine such that the air-fuel ratio in the internal combustion engine becomes a target air-fuel ratio based on the air-fuel ratio acquired by the second air-fuel ratio acquiring means,

wherein the air-fuel ratio controlling means prohibits any operation of the learning controlling means and the correcting

means during the air-fuel ratio control by the lean control means and the intermediate lean control means.

8. The air-fuel ratio control apparatus of the internal combustion engine according to any one of claims 1 to 7, further comprising: oxygen quantity acquiring means for acquiring a quantity of oxygen occluded in the second exhaust gas purifying catalyst by integrating an excess or shortage amounts of the quantity of oxygen in the exhaust gas calculated based on the air-fuel ratio in the internal combustion engine, both when judged that the air-fuel ratio in the internal combustion engine is lean and the air-fuel ratio acquired by the second air-fuel ratio acquiring means is lean and when judged that the air-fuel ratio in the internal combustion engine is rich and the air-fuel ratio acquired by the second air-fuel ratio acquiring means is rich,

wherein the air-fuel ratio controlling means judges as to whether the second exhaust gas purifying catalyst is lean state based on the quantity of oxygen acquired by the oxygen quantity acquiring means.

9. The air-fuel ratio control apparatus of the internal combustion engine according to claim 8, wherein the oxygen quantity acquiring means varies a maximum oxygen occlusion quantity of the second exhaust gas purifying catalyst according to the degradation state of the second exhaust gas purifying catalyst and the temperature of the second exhaust gas purifying catalyst.